

lateral pairs, which decrease from the first to the fourth, which is much reduced; on the rostro-gastric groove three pairs of teeth, of which the middle ones are the most strongly marked; basal joint of the inner antenna with three anterior processes; *ischiopodite of the third maxilliped longer than the meropodite*; the inner branch of the last three pleopoda is biarticulate; in the first pair of thoracic feet of the male it is the right chela that is modified.

A species from small depths found in the North Sea, on the shores of Ireland, in the Channel, and in the Mediterranean.

5. *Galathea strigosa*, Linné.

There are no epipodites upon any of the thoracic feet; carapace with the regions well marked by deep grooves furnished with long and close-set hairs; rostrum elongated, with nine teeth, of which the median one is the longest and the last lateral pair the smallest; from two to six teeth (according to age) upon the rostro-gastric line; two teeth a little behind the insertion of the outer antennæ and two other lateral ones on the hepatico-gastric grooves; basal joint of the inner antenna with three processes: *ischiopodite of the third maxilliped longer than the meropodite*; the inner branch of the last three pleopoda of the male is biarticulate. The two chelæ of the first thoracic feet are modified in the adult male.

This large species, which is found only at and below a depth of 10 fathoms, is the most widely distributed *Galathea* of our coasts; it has been noted as occurring from the North Cape and all the northern seas of Europe to the Canary Islands, and in the Mediterranean and Red Sea.—*Comptes Rendus*, June 11, 1888, p. 1686.

¶ *Remarks on the Phylogeny of the Lamellibranchiata.*

By Dr. BENJAMIN SHARP.

The author brought forward some points regarding the classification of the Lamellibranchiata, and stated that in considering this group a diversity of type was to be found that is equal to, if not greater than, that found in any class of the animal kingdom, with the possible exception of the Hexapoda.

In examining the different forms, he pointed out two well-marked extremes, *Ostrea* and *Aspergillum*. In the former, as is well known, the two large unequal shells entirely cover the body, and they are closed by one large muscle, the adductor. The large and important organ, so common in the Lamellibranchiata generally, the foot, is entirely absent. The mantle-edges are separated for nearly their whole extent, and there is no indication whatever of the mantle uniting to form a siphon.

In *Aspergillum*, on the other hand, the two shells are so diminutive

tive that they only cover an exceedingly small area of the animal's body, the siphon is enormously developed, and it is protected by a secretion of carbonate of lime, in which the shells are immovably imbedded; the mantle is closed throughout its entire length, except at the anterior end, where there is a minute opening, and at the mouths of the two siphonal tubes.

His object in making the communication was to prove that these two very marked and different types of Lamellibranchiata arose from a common, or what might be called a central type, and that a divergence from some cause set in, producing on one side the *Ostrea*, and on the other the *Aspergillum*.

As regards the whole class, he said there is no doubt, in his mind at least, that it is a degenerate one. Many anatomical and embryological facts, as well as their life-habits, point to this, it being an acknowledged fact that fixed or stationary animals are as a rule degenerate. The loss of the head in all adult forms, the presence of eyes in the head-area of some free-swimming embryos, and their later total disappearance, are some facts that point unquestionably to the degenerate condition of the whole group.

As to the facts of geology pointing to this conclusion, he quoted from Prof. Heilprin's work on the 'Distribution of Animals,' p. 265: "Almost everywhere, the Cephalophora, or head-bearing mollusks, antedate by one full period the Acephala, or headless forms, which indisputably represent a lower grade of organism." By considering the group as degenerate, the conditions of the case are answered, for the Lamellibranchiata certainly came off from the Gastropoda, after the latter had become well established, as the anatomical and embryological facts show, and the geological evidence would seem to indicate this to be the case.

Assuming, then, that the Lamellibranchiata have come off from the Gastropoda, Dr. Sharp then considered what was the form of the primitive type. It probably had a more or less developed foot, an organ that is present in all the Gastropoda, it possessed gills on each side of the foot, the mantle-edges were separate, and two adductors were present of about equal size. This type has survived to the present day, and, according to Lankester (art. Mollusca, Encycl. Brit. p. 685), is represented by forms like *Nucula* and *Trigonia*. The former belongs to the family Arcidæ (Claus), which is the oldest type that we know of, being found in the Silurian and Devonian. The shells of this family are equal; the adductor muscles of the same size, the mantle free, not being closed to form tubes like a siphon, foot well developed. The fulcrum of the shell is about equidistant from the adductors. In following one branch from this towards *Ostrea*, it is found that one muscle, the anterior, gradually gets smaller, as is the case in *Mytilus*, and exceedingly small in *Pinna*, until, in *Ostrea*, but one muscle is present. From the fact that in this advance the animal becomes more and more fixed, first by a secretion of the foot, the byssus, then by the shell

itself, the foot gradually is less and less used as an organ of locomotion, until it entirely disappears in *Ostrea*. The retractor muscles of the foot, now practically useless organs, are, however, still present.

The loss of one adductor muscle can probably be referred to mechanical causes. In studying the change of relation of the fulcrum to the adductors, he found that as the fulcrum moved forward (anteriorly) it increased the distance from the posterior, and lessened the distance from the anterior muscle. As this took place, the muscle furthest from the fulcrum was always the larger; in fact it must of necessity be so, as more power was needed at this point, while the near one, from the fact that it does not require much power, diminishes in size. In *Pinna* one muscle is very much, in fact four or five times, larger than the other, the smaller being close to the apex of the shell, in other words, close to the fulcrum.

As the fulcrum passes still further forward, a point is soon reached when both muscles come in line with the fulcrum; the larger one in this case takes all the work from the smaller one, which, from its now useless position, degenerates to disappearance.

A procedure from regular to irregular shell is to be seen in the freshwater forms. *Unio*, he held, is probably a freshwater *Mytilus*, which does not have any byssus present in the adult, but has one in the embryo. A form that closely resembles the oyster can be traced through *Etheria* to *Muelleria*, the so-called freshwater oyster. The latter has both adductors in the embryo, but only one, like *Ostrea*, in the adult.

Passing now in the other direction, Dr. Sharp pointed out the stages connecting the central type to the extreme in *Aspergillum*.

In passing out from the central type, the Arcas, the group known as the Siphonata appear, where, besides the large foot, it is found that the aboral portion of the mantle has united at two or three points, forming one or two tubes. In some forms of *Lucina*, by the union of the mantle a single tube is formed, the so-called anal siphon, which corresponds to the superior one when two are present; through this passes the water outwards, the inflowing water passing in through the large space between the mantle-edges, as in the asiphonated forms. In this form of *Lucina* specialization has only determined the direction of the outflowing current, which carries off the deoxygenated water and the excreta.

In *Cardium* the siphon is made up of two tubes; in other words the ingoing and outgoing currents are now determined. The edges of the mantle begin to adhere, leaving room only for the protrusion of the foot. In *Venus* the arrangement is practically the same:—a well-developed siphon, large wedge-like foot, which is a locomotor organ, a shell entirely covering the animal when it is closed, and two well-developed adductors, equal in size. The specialization in this line of development is in the direction of the siphon and closure of the mantle. *Mya* would represent a form leading to *Solen*; here the siphon is large, the mantle more or less

adherent, but the foot has degenerated to a useless organ, and the form of the body still somewhat resembles *Venus*, the shell, however, gaping at the aboral or siphonal end.

In *Solen* the edges of the shells cannot be brought together, or they gape, as it is said. In this form the new type has become established, and the animal resembles a cylinder; the large siphon fills up the aboral or gaping portion of the shell, while the boring-foot fills up the oral pole of the shell, the mantle being nearly closed between the foot and the siphonal openings.

The shells of *Mactra* are small for the body, and the siphons are so large that they cannot in any way be drawn into the shell; a large portion of the mantle also is without the limits of the shell, so that the edges of the shell do not touch even in life.

In *Teredo* no hinge-teeth are present, nor is even a ligament formed, an organ that is present in all other Lamellibranchs, except the members of this family and the next one to be considered; besides this a new element is found, namely accessory shell-pieces. The enormously developed siphon is four or five times the size of the rest of the body. The mantle-edges are firmly united except at the oral pole, where the boring-foot protrudes, and at the openings of the siphon. The true shells as well as the accessory pieces are movable, that is, not united with the calcareous secretion of the mantle.

In *Gastrochæna* the shells are very small, but still movable, the animal being enclosed in a calcareous shell, the secretion of the siphon. In *Clavagella*, a similar form, one shell is welded to the siphon-shell, the right one only being free, and in the extreme form of *Aspergillum* both shells are immovably fixed in the shelly tube that encloses the animal.

The freshwater forms *Cyclus*, *Cyprina*, &c. are probably related to *Cardium* and have received their new forms by moving into fresh water.

In summing up, Dr. Sharp showed two branches in the Lamellibranchiata, one going off from a form related to *Area*, the other toward *Ostrea*, the fulcrum moving from a position between the two equally large adductors toward the oral pole of the body. This brought the anterior adductor in a line with the fulcrum and posterior adductor, where, being of no use, it disappeared.

In the other direction development is in the antero-posterior direction, the shell, however, not taking part in the growth until a form is reached where the shell is exceedingly small and the animal protected by a supplementary deposit of carbonate of lime.—*Proc. Acad. Nat. Sci. Philad.* March 6, 1888, pp. 121-124.